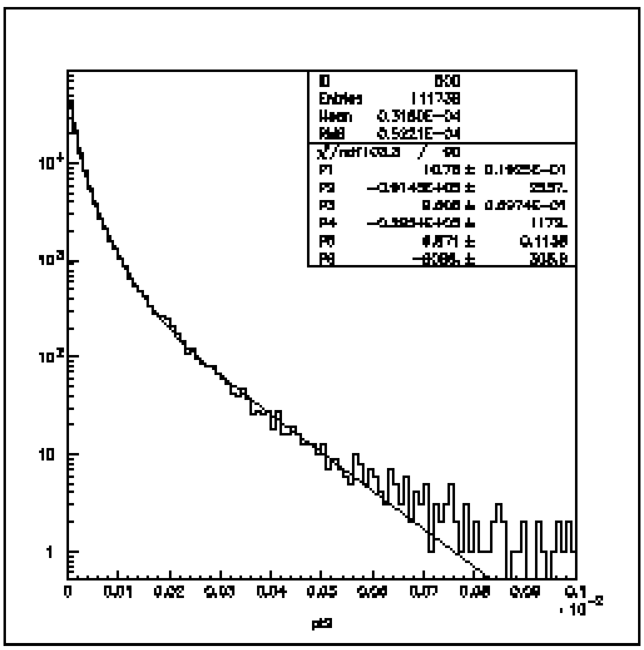
$K_L \to \pi^0(\pi^0)\mu e$ Recap

MDC, KTeV meeting, June 7, 2005

I have redefined the signal region by defining a likelihood variable which is the product of PDFs for the Kaon mass and p_t^2 distributions. Here is an example fit to the p_t^2 distribution for signal MC.



Fit to p_t^2 distribution for $K_L \to \pi^0\mu e$ signal MC

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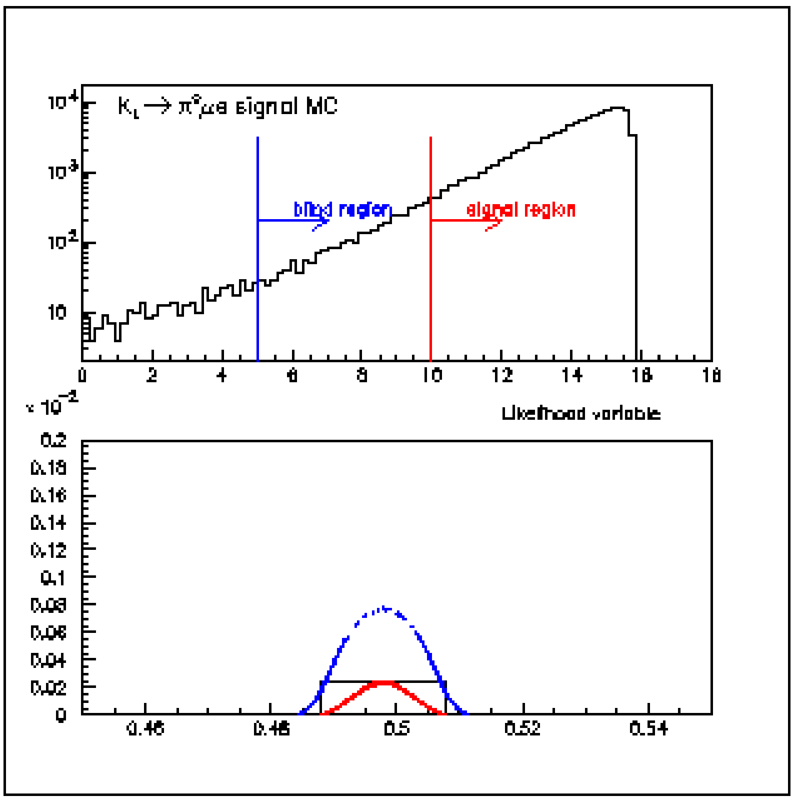
The likelihood variable is the product of the PDFs, and ia shown below for signal MC. The signal region is defined as $pdf > 10$, and a blind region is defined as $pdf > 5$. The lower plot compares the new signal region with the old signal box.

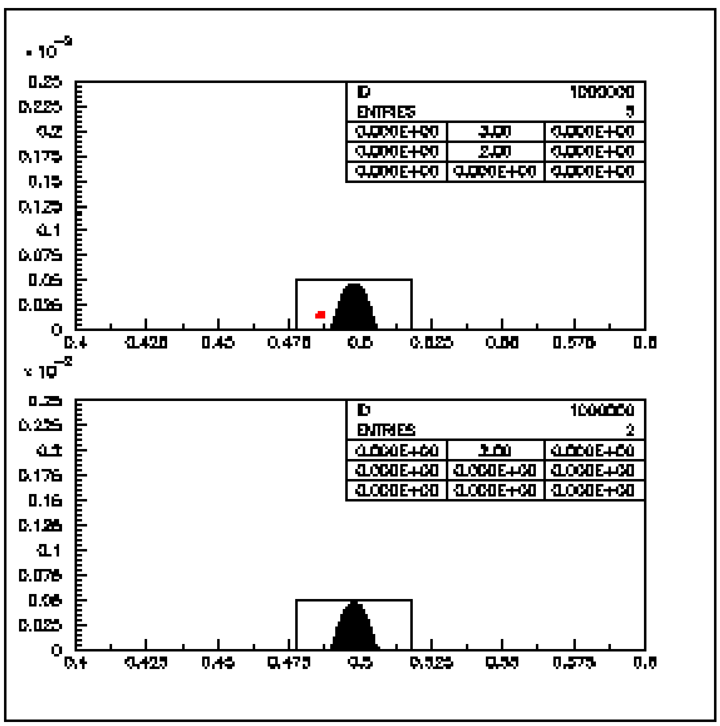


Top: Likelihood variable for signal Monte Carlo. Bottom: Comparison of the old signal box with the new signal region and blind region.

$K_L \to \pi^0\pi^0\mu e$ Status

Muon ID Cut

The only issue left the last time I talked was a possible muon ID cut. I decided to use a loose TRD cut as additional muon ID. The cut rejects 85% of electrons and retains 97% of all muons, based on K_{e3}s and $K_{\mu3}$s from trigger 2. The plot below shows the effect of this cut on the 97 data. Note that the two events in the study region are removed by the TRD cut.

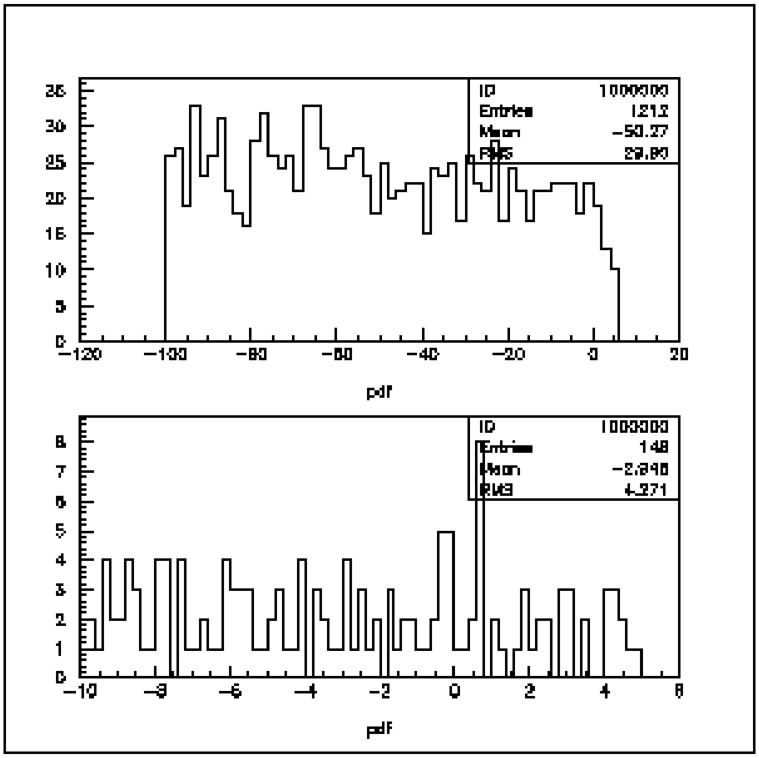


P_t^2 vs Kmass for the 97 data set. All cuts except the muon TRD cut are applied in the top plot. The bottom plot has the muon TRD cut applied. The signal region is blacked out. The blind region (pdf > 5) is still closed in the data.

$$K_L \to \pi^0\pi^0\mu e$$

Background Estimation

I have tried to estimate the background from the data by studying three cut sets: Anti-accidental cuts, kinematic, and particle ID. I remove all three sets, then apply them one at a time and in pairs. The plot below shows the likelihood variable *pdf* with all three removed.



Likelihood variable with all three cut sets removed. Top plot is for $-100 < pdf < 5$; bottom plot is for $-10 < pdf < 5$.

$K_L \to \pi^0\pi^0\mu e$

Background estimation

The assumptions I make are :

- The distribution in *pdf* is flat and remains flat after all cuts are imposed
- The three cut sets are independent, so that the total rejection is the product of the three individual rejection factors

The second assumption can be tested by applying the cuts separately and in groups. The table below summarizes the results

Cut set suppression	Kinematic	Anti-accidental	Particle ID
Only this cut is applied	0.128 ± 0.026	0.311 ± 0.038	0.25 ± 0.036
Only this cut is removed	0.081 ± 0.022	0.014 ± 0.009	0.034 ± 0.015
Expected when cut removed	0.078 ± 0.015	0.032 ± 0.008	0.040 ± 0.009

If assumption 2 is correct the two bottom rows should agree. It's not perfect, but not too bad.

$\boxed{K_L \to \pi^0\pi^0\mu e}$

For 99 data:

- Estimated background in the signal region is 0.5 $\pm$0.14 events
- Signal accepance is 2.02%
- Flux is 3.76 $\times 10^{11}$ K_L decays.
- If there are no events in the signal region, the 90%CL BR limit will be 2.7×10^{-10} from 99 data only.

For 97 data:

- Estimated background in the signal region is 0.1 $\pm$0.05 events
- Signal accepance is 1.80%
- Flux is 2.64 $\times 10^{11}$ K_L decays.
- If there are no events in the signal region, the BR limit will be 4.9×10^{-10} from 97 data only.

Combined 90% CL limit from both 97 and 99 data would be (assuming no events are observed in the signal region) BR($K_L \to \pi^0\pi^0\mu e$) $< 1.5 \times 10^{-10}$

Please see the long writeup:

/cdserv/taku/private/ktevdoc/e799/kpi0mue/pi0mue.ps

LFV Plans

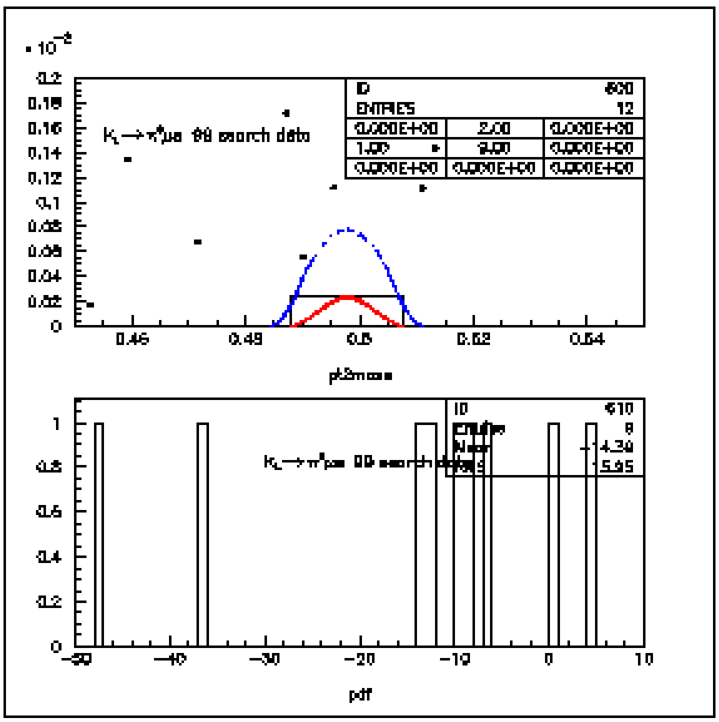
After some discussion with BobT, Leo, and Angela, we decided to combine the results for $K_L \to \pi^0\pi^0\mu e$, $K_L \to \pi^0\mu e$, and $K_L \to \pi^0\pi^0\pi^0$ ($\pi^0 \to \mu e$) into one paper.

For a coherent approach, $K_L \to \pi^0\mu e$ and $K_L \to \pi^0\pi^0\pi^0$ ($\pi^0 \to \mu e$) will be redone using the technique developed for $K_L \to \pi^0\pi^0\mu e$.

This requires a reanalysis of $K_L \to \pi^0\mu e$. Since we are redoing the analysis and have a new signal box, we can re-close the new signal box.

$K_L \to \pi^0 \mu e$ Status

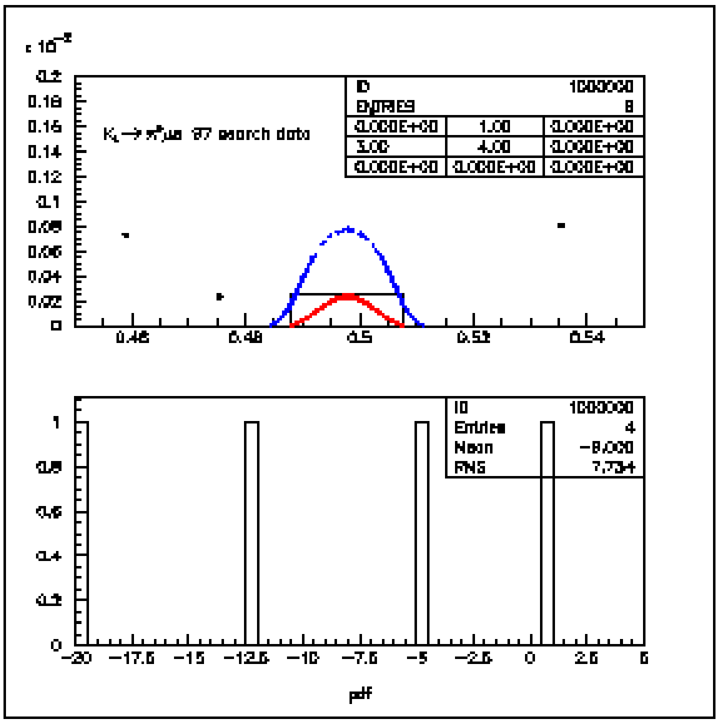
$K_L \to \pi^0 \mu e$ has been redone in v600 with the addition of the likelihood variable. The flux also had to be redone. The 99 data (with the new blind region closed) is shown below. The cuts are the same as Angela's, but with the fusion χ^2 loosened.



99 search data. Top plot is p_t^2 vs K mass with all cuts applied and the blind region (blue) and signal region (red) shown. The bottom plot shows the likelihood variable for the search data.

$K_L \to \pi^0 \mu e$ Status

The 97 data looks similar, but with less background.



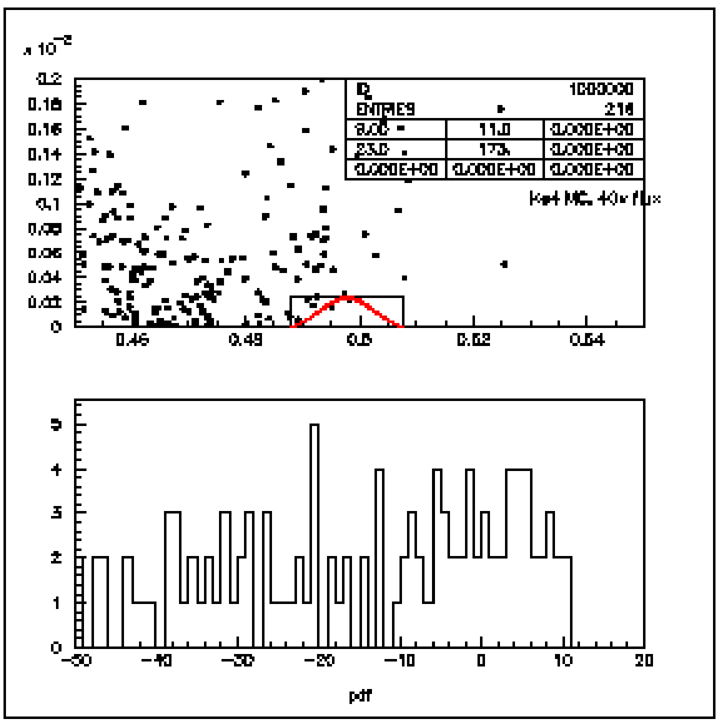
97 search data. Top plot is p_t^2 vs K mass with all cuts applied and the blind region (blue) and signal region (red) shown. The bottom plot shows the likelihood variable for the search data.

$K_L \to \pi^0 \mu e$ Status

Still outstanding: Estimate of background in the signal region.

A quick estimate, assuming the background is flat in the likelihood variable, gives an estimated background of 0.95 ± 0.32 events in the signal region for 99.

Important change in background estimate: The Pimue decay bug in KTEVANA, coupled with improved punchthrough modeling has significantly increased the background estimate from K_{e4}.



K_{e4} background Monte Carlo, 40X flux